MST e-NEWS

June 2016
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INSIDE

Veronica Livescu

Analyzing the microstructure of materials in support of Lab and NNSA programs

By Eileen Patterson, CPA-CAS

> *"I never in my life thought that I would work for Los Alamos National Laboratory, but I saw opportunities and took them. It all turned into something great."*

Veronica Livescu's career has taken quite a turn since she earned her master's in aerospace engineering in Romania in 1991. On her way from Bucharest to the Laboratory's Materials Science in Radiation and Dynamics Extremes group (MST-8), she changed not only countries but also disciplines, transforming herself from a mechanical engineer to a materials scientist.

The changes began as soon as she graduated. "Jobs in the aerospace industry were hard to find at that time," she said, "so for six years I worked for the Bucharest subway system—a combined engineering and programming position." But Livescu wanted research opportunities and followed that desire to New York State and the University of Buffalo–SUNY, where she earned a second master's (2001), this time in biomedical engineering, working with shape-memory alloys used in novel stents for treating arterial aneurysms. That master's work and then a job with a manufacturer of medical devices moved her to materials science and subsequently to Los Alamos.

In Los Alamos's Electron Microscopy Laboratory, Veronica Livescu analyzes a range of materials' properties, with the ultimate goal of creating materials designed for a specific function. She is pictured above using a focused ion beam/scanning electron microscope.
Photo by Sandra Valdez, NIE-CS

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Los Alamos National Laboratory

“Let’s all keep focus on safety and keep an eye on each other so that we can all go home safe at the end of the day to enjoy all of the wonderful things to do this summer with our family and friends.”

From David’s desk . . .

The summer months are one of my favorite times of the year in Los Alamos with all of the outdoor activities that are available to us. It is also a popular time to go on family vacations and prepare for a child’s first day of school, a transition to high school, or taking kids to college. Here at the Lab, we also see the character of our Laboratory change with the influx of summer students. I always enjoy seeing the Laboratory become more vibrant with the students arriving and engaging with our scientists and technicians.

With this change in routine, we may become distracted at work and find ourselves in unsafe situations. Recently, the Laboratory and more specifically the EPS Associate Directorate has been seeing an increase in the number of safety incidents. Luckily most of these were near misses and no employees were injured. However, several of these events were one step away from seriously injuring our employees. In one case, the event was due to a lack of communication between workers (one was new to the work team). In another case, it was related to not being aware of changes in the work environment. In yet another, an employee performed a chemical experiment that was outside the bounds of the approved IWD and had an unexpected over-pressurization. I would like to reiterate the importance of frequently discussing the specifics of your work with your co-workers and PICs. The expectation in MST Division is that this is done at a minimum weekly in a team meeting or PIC-led safety meeting. In a science and discovery environment, it is relatively easy for us to wander outside the scope of our previously analyzed safety envelope, e.g., changing the temperature of a reaction, changing types or amounts of chemicals, or changing the method of sample preparation. Therefore it is important that we talk about our work frequently with the team leader or PIC to help identify the conditions that would put us outside the bounds of our analyzed hazards—and to plan appropriately.

I recognize that it can be difficult to make changes to our IWDs and that this can be a barrier to us exploring our scientific curiosity in trying new things. In alignment with Mary Hockaday’s IWM improvement initiatives, Dianne Wilburn and I will be working with the FOD and Institutional ESH to explore alternatives to our current cumbersome IWD process and approval cycles. If you are interested in helping us improve our IWM process and have ideas on how to enable a more flexible R&D environment while still ensuring we have adequately analyzed our hazards, please contact Dianne or me to get involved.

Let’s all keep focus on safety and keep an eye on each other so that we can all go home safe at the end of the day to enjoy all of the wonderful things to do this summer with our family and friends.

Thanks,
Dave Teter
MST Division Leader

Livescu cont.

On staff since 2005, Livescu is a member of MST-8's Dynamic Materials Properties team—a critical member, according to team leader George T. (Rusty) Gray III. "She's a gifted, passionate researcher," he said, "contributing to a spectrum of fundamental, programmatic, and exploratory research topics important to the Laboratory and broader NNSA programs."

"The team measures the static and dynamic properties of a large range of materials," said Livescu. "We're looking at the results of dynamic shock loading in metallic structures and at the influence of materials' internal structure on deformation, void nucleation and growth, and ultimate failure." She uses optical microscopy, scanning electron microscopy, and electron backscatter diffraction (EBSD) to characterize a material's microstructure—the size and crystallographic orientation of the material's grains, the interfaces between the grains, and the presence of porosity (small voids) and/or impurities.

"Every material is different," said Livescu, "and despite the fact that we understand the importance of a material's structure on its properties, we still have a lot to learn about the mechanisms involved in the generation of damage under shock-loading conditions." Detecting subtle changes in a material's microstructure can unveil critical information regarding the material's response to loading, so when possible, she focuses on using software that generates three-dimensional volumes from the EBSD analysis to create material models.

Because processing greatly influences microstructure and therefore a material's stress response, Livescu and her colleagues have recently chosen two kinds of samples to work with, some that were traditionally manufactured—wrought and annealed—and others that were created by additive manufacturing, in which powdered metal is melted as it gets deposited in ultrathin layers. The microstructure of the two, she said, is quite different. "The additively manufactured materials have a much finer grained, more complex microstructure, exotic and challenging at the same time. In addition to the polycrystalline microstructure, the layer-by-layer deposition results in a macroscale pattern, which looks almost like rows of fish scales."

Livescu analyzes the samples both before and after the shock-loading experiments, many of which she and the team do themselves, using a gas gun and split Hopkinson pressure bar for one-dimensional shocks and mechanical frames for the slow, steady pressure of quasistatic loading. "In addition," she said, "I study samples that were tested using high explosives, which lets me tap into the effect of three-dimensional complex loading. I get those samples by collaborating with people from other divisions."

Collaboration is the reason for the efforts of Livescu and the team. Their work supports Theoretical Division's development of models and simulations to better predict how materials behave under extreme conditions. The work is important to stockpile stewardship and is one of DOE's scientific grand challenges.

Livescu said she never expected to do such work back in 1991, before she started down the path to her current job. "I never in my life thought that I would work for Los Alamos National Laboratory, but I saw opportunities and took them. It all turned into something great."

Veronica Livescu's favorite experiment

What: Evaluating the 3D void damage distribution in tantalum discs shocked in plate-impact experiments

When: 2006

Where: The MST Division metallography lab and electron microscopy lab

Who: Veronica Livescu, John F. Bingert (MST-8), Scott E. Dillard and Daniel L. Worthington (LANL and UC Davis, Materials Design Institute)

How: Serial sections, 5 microns apart, were performed in the cross section of each disc and analyzed with optical microscopy and electron backscatter diffraction. The damage field and local alterations in the microstructure were reconstructed in 3D and quantified.

The "a-ha" moment: We found that the distribution of damage throughout a shocked specimen is very anisotropic and that the 3D analysis method produces the most accurate characterization of the damage field and meaningful statistics regarding the damage feature and the deformation field associated with the void network. Initial voids were nucleated at grain boundaries. At later times, when the plastic fields of the individual void begin to interact, shear localizations begin to develop. These, in turn, become preferred nucleation sites where new voids are nucleated. At long enough pulse durations, the voids coalesce and generate a spall surface.

MST-8 scientists guide national efforts to overcome nuclear energy technical challenges

Chosen for new leadership roles in four DOE-Office of Nuclear Energy programs, David Andersson, Stuart Maloy, Chris Stanek, and Ken McClellan (Materials Science in Radiation and Dynamics Extremes, MST-8) are working with collaborators worldwide to develop future nuclear reactor designs and fuel cycle options.

David Andersson has joined the Consortium for Advanced Simulation of Light Water Reactors (CASL) leadership team as a deputy focus area lead for fuels, materials and chemistry. He collaborates with Focus Area Lead Brian Wirth (University of Tennessee) and Deputy Focus Area Lead Richard Williamson (Idaho National Laboratory) to guide the development of material models and simulation capabilities enabling CASL to address core challenge problems, including pellet-cladding interaction and deposition of corrosion products on cladding. Los Alamos is a founding partner of CASL, which was established in 2010 to develop modeling and simulation technology for a virtual version of existing operating nuclear reactors.

Stuart A. Maloy is reactor materials technical lead for the Nuclear Energy Enabling Technologies (NEET) program. His position is part of the reactor materials crosscut effort supporting the development of revolutionary materials and providing broad-based, modern materials science benefiting DOE-NE objectives. This effort is accomplished through innovative materials development, promoting the use of modern materials science and establishing new, shared research partnerships. Maloy provides management support and fosters greater integration across DOE-NE programs, other offices, and international interests.

Ken McClellan is the Advanced Light Water Reactor (LWR) Fuels thrust area lead for the Advanced Fuels Campaign under DOE-NE's Fuel Cycle R&D program. He is responsible for overall coordination and integration of the various LWR fuel activities at the national laboratories. A primary focus is development of fuels with enhanced accident tolerance for application in commercial power reactors. In addition to the national laboratory activities, he also supports integration of university and industry-led LWR fuel technology development projects as well as international collaborations.

Chris Stanek was recently named the National Technical Director for the Nuclear Energy Advanced Modeling and Simulation (NEAMS) program, which develops, applies, deploys, and supports a predictive modeling and simulation toolkit for the design and analysis of current and future nuclear energy systems using computing architectures from laptops to leadership class facilities. Los Alamos National Laboratory primarily contributes to the advanced nuclear fuel development by developing multiscale models of fuel performance.

David Andersson

Stuart Maloy

Ken McClellan

Chris Stanek

More than 50% of the world's clean energy is generated from nuclear power plants. The Office of Nuclear Energy's mission is "to advance nuclear power as a resource capable of meeting the Nation's energy, environmental, and national security needs by resolving technical, cost, safety, proliferation resistance, and security barriers through research, development, and demonstration as appropriate."

Technical contact: Chris Stanek

First-ever scanning probe microscopy capabilities for plutonium

The first-ever scanning probe microscopy (SPM) capabilities dedicated for plutonium surface studies became operational at the end of 2015 in the Target Fabrication Facility (TFF).

A collaboration between Engineered Materials (MST-7), Materials Science in Radiation and Dynamics Extremes (MST-8), Nuclear Materials Science (MST-16), Physical Chemistry and Applied Spectroscopy (C-PCS), and Nuclear and Radiochemistry (C-NR) succeeded in establishing this unique Los Alamos capability. It is focused on both fundamental atomic-scale plutonium surface science investigations necessary to validate theoretical modeling codes and macroscopic signatures studies of plutonium surfaces relevant to the nuclear weapons engineering community.

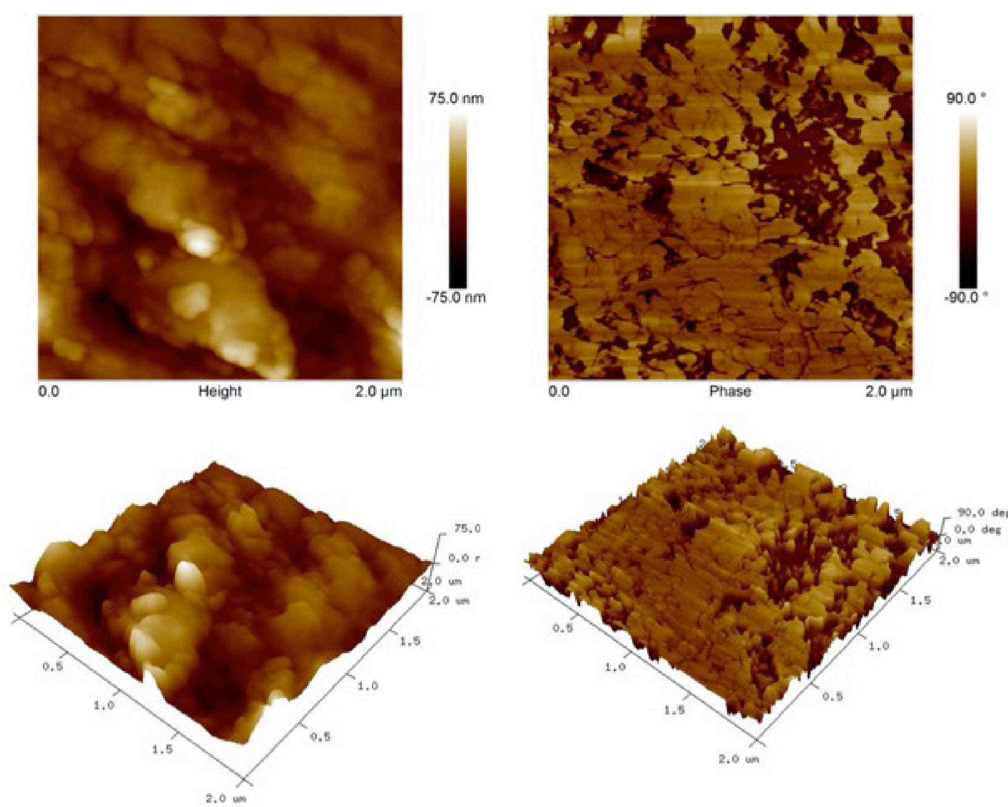
The capability includes a glove box-housed atomic force microscope (GB-AFM) and an ultra-high vacuum scanning tunneling microscope (UHV-STM) along with low-energy electron diffraction (LEED) and Auger electron spectroscopy (AES) techniques that provide complimentary structural and chemical plutonium surface analysis. The AFM instrument is contained within an inert atmosphere glove box due to the radiological and toxic plutonium hazards. In addition, the GB-AFM and UHV-STM instruments are equipped with gas-dosing systems, enabling high-resolution studies of plutonium surface physical-chemical property changes (such as morphology, local defect and electronic structure, composition, etc.) induced by gas exposures under ambient pressure and UHV, respectively. Unlike electron microscopy, these SPM techniques are capable of nondestructively producing three-dimensional (3D) surface topography images with nanometer-scale resolution in all three directions.

Surface imaging of a mechanically polished 7 atomic % Ga-stabilized δ-plutonium coupon (δ-Pu<7at%Ga>) was carried out by both UHV-STM and GB-AFM instruments. The surface quality was not smooth enough for UHV-STM to obtain atomically resolved images, whereas precise images were collected by GB-AFM. The figure shows AFM images obtained from the surface of a δ-Pu<7at%Ga> coupon prepared at the PF-4 facility. The topography image revealed a surface with an average roughness, Ra, of ~ 9nm and features with widths ranging from 50-150 nm and heights from 30–60 nm. The simultaneously obtained phase contrast image pointed to sub-µm scale variations of mechanical properties on the δ-Pu surface, which are not always representative of surface topography. Detailed studies of the nature of these plutonium surface irregularities (likely related to chemical composition, crystallographic orientation variations, and mechanically induced damage from polishing) and atomically smooth plutonium surface preparations are underway.

Participants include Igor Usov, Miles Beaux, Miguel Santiago-Cordoba, Douglas Vodnik (MST-7), Adam Zocco (now with Detonator Technology, W-6), William Blumenthal (MST-8), Mike Ramos, Scott Richmond, Tom Venhaus, Jeremy Mitchell (MST-16), Stephen Joyce (C-PCS), and Marianne Wilkerson (C-NR).

Establishment of the SPM capabilities aimed at plutonium characterization was supported by the Laboratory Directed Research and Development program (Marianne Wilkerson, principal investigator). A major refurbishment and upgrade, necessary to ensure these capabilities remain state of the art for the long term, was funded by Science Campaign 1 (William Blumenthal, project lead). This work supports the Laboratory's missions related to Stockpile Stewardship and the Materials for the Future science pillar.

Technical contact: Igor Usov



3D AFM height (corresponding to surface topography) and phase (representing surface mechanical properties) images of as-received δ-Pu<7at%Ga> taken simultaneously from the same region.

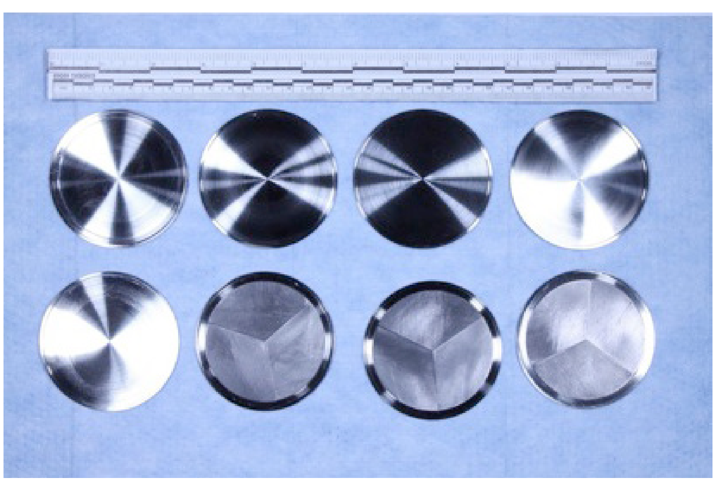
Laboratory metallurgists make thorium targets for production of cancer-fighting isotopes

Together, Los Alamos, Brookhaven, and Oak Ridge national laboratories are developing a large-scale accelerator production capability for actinium-225 (Ac-225), a rare radioactive isotope that attacks cancer cells without damaging nearby healthy cells. Encapsulated thorium target assemblies are being used to produce Ac-225 via irradiation using high-energy proton beams at accelerator facilities located at Brookhaven and Los Alamos labs. Irradiated targets are shipped to Oak Ridge for chemical processing, with distribution of isolated Ac-225 for initial evaluation studies conducted by independent researchers and clinicians worldwide.

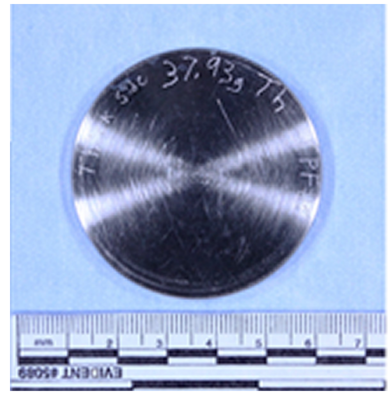
This tri-lab effort is driven by the pressing need to provide enough Ac-225 to support clinical trials of medicines based on this isotope. The current supply of Ac-225 available to the research and commercial market is inadequate. The tri-lab team, through the auspices of DOE's National Isotope Program, is developing chemical processing techniques and production-scale targetry to prepare for Ac-225 manufacturing.

None of this would be possible without the capability to manufacture encapsulated thorium capsules for irradiation. The Sigma Complex at Los Alamos is the only place in the United States with the equipment, expertise, and access for melting, forming, and machining thorium, which is radioactive. The Isotope Program has collected a ready supply of thorium at Los Alamos for the effort.

Over the past two years, members of the Metallurgy group (MST-6, now Sigma Division) have produced 11 thorium targets for the Los Alamos Isotope Production Facility, where researchers test the capsules to ensure their viability during irradiation and measure the Ac-225 yield to address the increasing worldwide clinical demand. The Los Alamos Neutron Science Center is one of the nation's most powerful proton linear accelerators, providing protons at 100 MeV to the Isotope Production Facility for the purpose of large-scale generation of radionuclides needed by the larger isotope community.



From left, weld test specimen and three thorium target assemblies made at the Sigma Facility at Los Alamos National Laboratory to be irradiated at Brookhaven National Laboratory.



This thick thorium target assembly is the 11th thorium target made at Sigma for the Los Alamos Isotope Production Facility.

In a recent achievement showing Sigma's growing role in the tri-lab effort, MST-6 machinists, welders, and metallographers manufactured three extremely thin thorium irradiation targets for Brookhaven National Laboratory. The fabrication of these targets required exceptional skill and precision to meet Brookhaven's specifications. Brookhaven's specifications for 0.015-inch-thick thorium targets in a capsule with a 0.020-inch-thick window presented new challenges. Jeff Scott rolled existing thorium plate to the 0.015-inch-thick dimension, and machinist Jeff Robison machined the thorium target pieces. Rick Hudson machined the thin Inconel capsule halves, which Matt Dvornak electron beam welded together with the thorium inside. The welding test specimen contained a 0.015-inch-thick stainless steel disk to mimic the thorium target. After welding, a hole was bored into the test specimen's center for helium leak testing. The test confirmed that the target did not leak. These targets will be irradiated at the Brookhaven Linac Isotope Producer in support of ongoing Ac-225 product evaluation studies.

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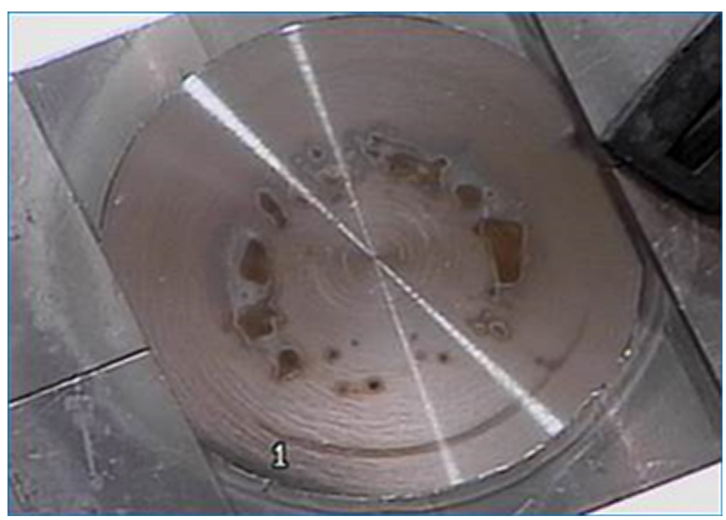

A thorium target prepared by the Sigma team after irradiation at the Los Alamos Isotope Production Facility. Scorching pattern is a result of circularly rastered proton beam interactions with the target surface.

HeadsUP!

Safety alert: Warmer weather means more bicycles, motorcycles on roads

Warmer weather means an increase in bicycles and motorcycles on roads. Motorists should increase their distance from bicyclists and motorcyclists and share the road. Likewise for bicyclists and motorcyclists who also should make themselves visible to other motorists and follow all applicable rules of the road.

"Today and every day, all Laboratory employees, whether riding a bicycle or motorcycle or driving a car, have an obligation to keep each other safe so that we can return home to our families and loved ones at the end of the day," said Richard Sturgeon of Environmental Compliance Programs (EPC-CP), chair of the Laboratory's Motorcycle Safety Committee.

WSST Fest is coming July 21

Learn about employee-driven safety and security programs and successes at the seventh annual WSST Fest July 21 from 9 a.m. to 2 p.m. in the J. Robert Oppenheimer Study Center and the surface parking lot of the nearby parking structure at TA-3. The theme is "Learning from Our Past, Embracing Our Future."

Sponsored by the Institutional Worker Safety and Security Team, WSST Fest features hands-on safety and security demonstrations and information booths staffed by employees who serve on organizational WSSTs. The activities are designed to raise awareness of worker safety and security initiatives and successes.

Booth reservations
Organizations can submit a booth request for WSST Fest from the Institutional Worker Safety and Security Team website. Note the number of tables needed, location (inside or outside), banners and electrical power, if needed, or any other special requirements. The deadline to register booths is Monday, July 11.

Free lunch, provided by the Director's Office, will be served and Los Alamos managers have volunteered to help serve lunch. Music will be provided.

Volunteers needed
Help make WSST Fest a success by volunteering for a number of activities, such as helping to set up and take down booths, serving lunch to employees, working the sign-in table, acting as "runners" and providing assistance to attendees. Employees interested in volunteering are asked to write to 2016wsstfest@lanl.gov by July 11.

Thorium targets cont.

As Los Alamos established a versatile thorium target manufacturing capability, the following MST-6 staff have been instrumental over the past two years: Richard W. Hudson, Andrew N. Duffield (now with MET-2, Pit Integrated Technologies), Matthew J. Dvornak, Jesse N. Martinez, Matthew T. Strandy, Joel D. Montalvo, Bo S. Folks, Jeffrey C. Robison, Tim V. Beard, Victor D. Vargas, Maria I. Pena, Hunter Swenson, Daniel A. Aragon (now with Prototype Fabrication-Weapon Fabrication Services), Jeffrey E. Scott, Kester D. Clarke, Robert T. Forsyth, Daniel A. Javernick, James C. Foley, and Jason C. Cooley.

This work was supported by the United States Department of Energy, Office of Science via funding from the Isotope Development and Production for Research and Applications subprogram in the Office of Nuclear Physics. This new capability at Sigma supports the Lab's national security mission and Materials for the Future science pillar.

Technical contact: Jason C. Cooley

Celebrating service

Congratulations to the following MST Division employees, who celebrated service anniversaries recently:

Lynne Goodwin, MST-7 .... 25 years
Rodney McCabe, MST-8 .... 15 years
Beverly Basey-Jones, MST-DO .... 10 years

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